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Treatment of Longitudinal Epiphyseal Bracket by Excision and Polymethylmethacrylate Insertion at the Preossified Disease Stage

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ABSTRACT

Longitudinal epiphyseal bracket is a rare ossification anomaly involving the tubular bones of the hand or foot that have a proximal epiphysis, which becomes deformed as a result of the bracket. Untreated, the deformity becomes worse with age, because longitudinal growth cannot occur. The present report discusses the use of polymethylmethacrylate at the preossified disease stage in 2 patients with first metatarsal involvement. A medical record and radiographic review was performed for 2 children (3 feet), aged 1 year and 2 years and 5 months, who were treated with insertion of polymethylmethacrylate after excision of the aberrant epiphyseal bracket. Two different radiographic parameters (i.e., the intraosseous angulation and the metadiaphyseal length index) were used to measure the effect of treatment on the subsequent longitudinal growth of the metatarsals. An excellent clinical result after a long follow-up period was observed in 2 feet, and a good result was documented in 1 foot, which developed hallux valgus angulation. The use of polymethylmethacrylate as an interposition material after excision of the aberrant metatarsal epiphyseal bracket appeared to be an effective method of treatment during the preossified first stage of the disease, despite the general recommendation to use a cement spacer during the third ossified stage. Normal longitudinal growth of the metatarsals was noted without complications or risk of deformity recurrence.

Longitudinal epiphyseal bracket (LEB) is an ossification anomaly involving the tubular bones of the hand or foot that have a proximal epiphysis, in which an arcuate secondary ossification center brackets the diaphysis and metaphysis of a phalanx, metacarpal, or metatarsal. When it affects the first metatarsal, the longitudinal metatarsal epiphyseal bracket will lead to a short, broad, trapezoidal metatarsal with deviation of the metatarsophalangeal joint and hallux varus. This condition can also cause difficulty in wearing shoes, psychological problems, and metatarsalgia. LEB can be associated with various syndromes, an example of which is the Rubinstein-Taybi syndrome (1). The deformity was first described by Jones as the "delta phalanx," in which the phalanx is triangular and has a continuous physis running from the proximal to distal end along the shortened side (2). Light and Ogden (3) suggested the term "longitudinal epiphyseal bracket" for this anomaly.

The LEB can exist as an isolated deformity but is commonly associated with digital deformities such as polydactyly, congenital hallux varus, and clinodactyly. Watanabe et al (4) introduced their classification system related to polydactyly of the foot, according to ray involvement and levels of duplication. They classified foot polydactyly into 3 broad groups: medial ray, central ray, and lateral ray, with each group further subdivided into tarsal, metatarsal, proximal phalangeal, and distal phalangeal subgroups (4). Early detection and adequate excision of an LEB can reduce the risk of residual deformity and the need for revision surgery (5).

The natural history of LEB has been divided into 4 radiographic stages. In stage I, the epiphyseal bracket is cartilaginous and not yet visible. In stage II, secondary ossification centers have appeared at the epiphysis and along the diaphysis. In stage III, a continuous ossified bracket of epiphyses will outline 1 side of the diaphysis. In stage IV, the bracket and the growth plate will be ossified and united with the metatarsal diaphysis (Fig. 1). These stages are associated with progressive osseous shortening and angular deformity (6).

The purpose of the present study was to report the long-term follow-up data from 2 patients (3 feet) with LEB of the great toe metatarsals at stage I. All were treated by central physiolysis, as described by Mubarak et al (7), with an interposition block of polymethylmethacrylate (PMMA). The parents of both patients were informed that data concerning their child's case would be submitted for publication, and they consented.

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Conflict of Interest: None reported.

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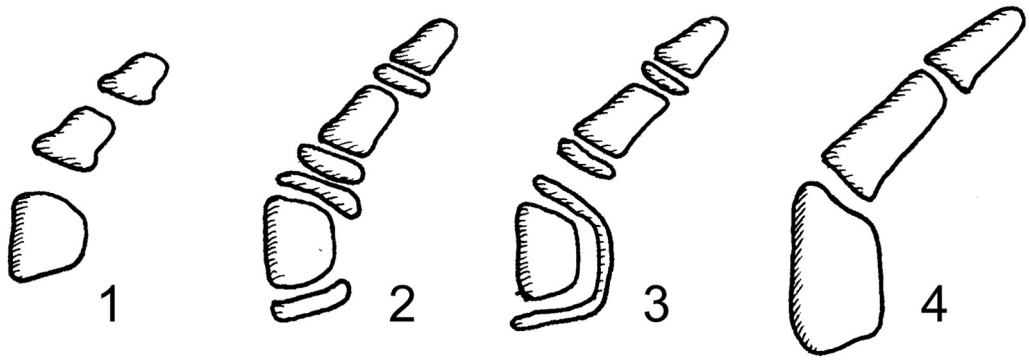

Fig. 1. Classification of longitudinal epiphyseal bracket. Original figure. Based on classification in Shea et al (6).

Case Reports

We report the description of 2 children, representing 3 feet, with tibial foot polydactyly (4), observed at our institution from January 1999 to December 2005. All subjects were analyzed using the data collected from the medical records and radiographs. The clinical outcomes were evaluated at the most recent examination, using the format published by Phelps and Grogan (8). In their classification, an excellent foot displayed no pain, no shoe wear issues, no calluses, no significant residual deformity, and a cosmetically acceptable appearance. A good result included feet with occasional pain, difficulty with some shoe styles, and no painful calluses or with minimal residual toe deformity. A poor outcome was defined as a foot with constant pain, marked shoe wear difficulty, persistently painful calluses, substantial deformity of the residual toes, and an objectionable scar appearance. The tibial polydactyly was classified according to Watanabe et al (4) for medial ray (preaxial) polydactyly of the foot. Furthermore, we used 2 parameters described by Shea et al (6) to measure the effect of treatment on the subsequent longitudinal growth of the first metatarsal: the intraosseous angulation and the metadiaphyseal length index. Intraosseous angulation is defined as the angle subtended by lines drawn parallel to the proximal and distal joint surfaces of the first metatarsal. The metadiaphyseal length index was defined as the ratio between the lengths of the shorter, bracketed side of the bone and that of the nonbracketed side. In a normal first metatarsal, this ratio will be approximately equal to 1 (6) (Fig. 2).

We adopted the surgical technique described by Mubarak et al (7). Under tourniquet control, an incision was made over the dorsomedial aspect of the great toe metatarsal, and the periosteum was exposed. The midportion of the bracket epiphysis was located with a fine needle. Under loupe magnification, the central, or longitudinal, portion of the epiphyseal bracket is removed with a small rongeur and curette until the cortical bone of the diaphysis was encountered. The dissection was continued proximally and distally to the point at which the epiphysis becomes transversely oriented (at the proximal and distal ends of the metatarsal). The defect was irrigated and filled with PMMA cement. The cement was held in place by a small transversely oriented Kirschner wire cut flush with the cement. The extra (redundant) big toe was amputated, and the hallux varus deformity of the true big toe was corrected by lateral capsulorrhaphy, and a smooth Kirschner wire was driven retrograde through the phalanges and metatarsal to maintain the correction. Postoperatively, the patient was placed in a short leg cast for 6 weeks. At that point, the phalangeal Kirschner wire was removed, and a short leg walking cast was used for 4 more weeks (7). All the patients underwent surgery before ossification of the LEB (stage 1).

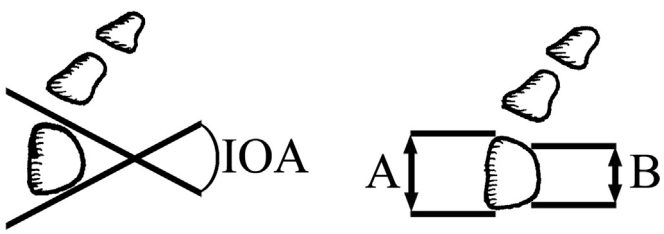

Fig. 2. Intraosseous angulation (IOA) and metadiaphyseal length index. Original figure. Based on classification in Shea et al (6).

Case 1

Our first patient was a male with hallux varus and an extra left great toe, classified as a medial ray polydactyly, proximal phalangeal type according to Watanabe et al (4) (Fig. 3*A*). At 1 year of age, he underwent excision of the extra great toe and the Mubarak stage III procedure for his first ray LEB (Fig. 3*B*). At 14 years postoperatively, when the patient was 15 years old, a follow-up evaluation revealed an asymptomatic patient with grossly normal hallux alignment and size (Fig. 3*C* and *D*). The child was functioning without any limitations, including sport activities. The result was excellent according to the Phelps and Gorgan (8) classification.

On examination, he was walking normally. The metatarsophalangeal joint was moving freely with 20° of dorsiflexion and plantar flexion. The second toe had a slight hammertoe position. Radiologically, intraosseous angulation had been corrected from a preoperative value of 47° to a postoperative value of 7° (Fig. 3*E*). The preoperative metadiaphyseal length ratio of 0.7 had improved to 0.92. The proximal phalanx and the first metatarsal were perfectly aligned. Some extra bone formation was noted on the medial aspect of the first metatarsus, this was not palpable under the skin and was painless to local pressure.

Case 2

Our second patient was a male, born with bilateral extra great toes, the left in varus. Medial ray polydactyly and proximal phalangeal type were present bilaterally according to Watanabe et al (4) (Fig. 4*A* and *B*). At age 2 years and 5 months, the child underwent excision of the extra great toes and the Mubarak stage III procedure for both first ray LEB (Fig. 4*C*).

The patient was recently re-examined at 10 years and 6 months old, 8 years after his original surgery. He reported good function, with performance of all sport activities without any restrictions, and painless activity. According to Phelps and Gorgan (8), the result could be classified as excellent on the left side and good on the right. On examination, hallux valgus was noted on the right side. The range of